

# PUBLICLY AVAILABLE SPECIFICATION PRE-STANDARD



**Assessment methods of the human exposure to electric and magnetic fields from wireless power transfer systems – Models, instrumentation, measurement and numerical methods and procedures (frequency range of 1 kHz to 30 MHz)**

IEC PAS 63184:2021

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## CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
2 Normative references .....	11
3 Terms and definitions .....	11
4 Symbols and abbreviated terms.....	15
4.1 Physical quantities.....	15
4.2 Constants .....	15
4.3 Abbreviated terms.....	15
5 Assessment procedures .....	16
5.1 General.....	16
5.2 Conformity assessment considering direct effects .....	17
5.2.1 General .....	17
5.2.2 Evaluation based on coil current.....	17
5.2.3 Evaluation of incident fields against reference levels .....	18
5.2.4 Evaluation of incident fields against basic restrictions.....	18
5.2.5 Evaluation of internal E-field, current density and/or SAR against basic restrictions.....	22
5.3 Conformity assessment considering indirect effect.....	22
6 Measurement methods .....	24
6.1 Incident fields .....	24
6.1.1 General procedure.....	24
6.1.2 Equipment.....	25
6.2 SAR.....	26
6.3 Contact currents .....	27
6.3.1 General .....	27
6.3.2 Equipment .....	28
6.3.3 Measurements.....	29
7 Computational assessment methods.....	30
7.1 General.....	30
7.2 Quasi-static approximation.....	30
7.3 Computational assessment against the basic restrictions.....	31
7.3.1 General .....	31
7.3.2 Peak spatial-average SAR.....	31
7.3.3 Whole-body average SAR.....	31
8 Combination of measurement and computational assessment methods .....	32
8.1 General.....	32
8.2 Measurement of magnetic field .....	32
8.3 Computational analyses of induced quantities.....	32
8.4 Computational assessment against the basic restrictions.....	33
9 Uncertainty assessments.....	33
9.1 Measurement methods.....	33
9.2 Numerical methods .....	34
9.3 Assessment of combining measurement and numerical methods .....	35
Annex A (informative) Exposure evaluations using approximations .....	37
Annex B (normative) Calibration methods .....	39

B.1	General.....	39
B.2	E-field and H-field calibration .....	39
B.2.1	Standard field generation methods .....	39
B.2.2	Characteristics to be measured .....	39
B.2.3	Frequency domain calibration .....	40
B.2.4	E-field calibration.....	44
B.3	Gradient response verification .....	48
B.3.1	General .....	48
B.3.2	H-field gradient verification: Main steps .....	48
B.3.3	Uncertainty for H-field gradient verification .....	48
B.4	Dosimetric probe calibration.....	49
B.4.1	General .....	49
B.4.2	Calibration with short dipole antennas via transmit antenna factor .....	49
B.4.3	Uncertainty .....	52
Annex C (normative)	Verification and validation methods for measurement.....	53
C.1	General.....	53
C.2	Objective .....	53
C.3	Measurement setup and procedure for system verification and system validation .....	53
C.4	Measurement system verification: test procedure.....	54
C.5	Measurement system validation: test procedure .....	54
Annex D (informative)	Dependency of SAR on phantom property and size .....	55
D.1	Phantom property .....	55
D.2	Phantom size .....	58
Annex E (informative)	Extrapolation methods of SAR measurement .....	61
E.1	General.....	61
E.2	Measurement and interpolation of electric field inside a phantom.....	61
E.2.1	General .....	61
E.2.2	Extrapolation functions .....	61
E.2.3	Three steps for determination of spatial-peak SAR .....	62
E.2.4	Validation of measurement methods using extrapolation.....	62
E.2.5	Uncertainty .....	64
Annex F (informative)	Numerical calculation methods .....	66
F.1	General.....	66
F.2	Quasi-static finite element method .....	66
F.3	Scalar potential finite difference method .....	67
F.4	Impedance method .....	67
F.5	Finite-difference time-domain method .....	68
F.6	Hybrid technique of MoM and FDTD method .....	68
F.7	Hybrid technique of FEM and SPFD method .....	69
Annex G (informative)	Averaging algorithms .....	70
G.1	Current density averaging over an area .....	70
G.1.1	General .....	70
G.1.2	Calculation of the current density in a Cartesian voxel.....	70
G.1.3	Calculation of the current density in a tetrahedron .....	71
G.1.4	Calculation of $J_{av}$ .....	71
G.2	E-field averaging in a cubical volume .....	72
G.3	E-field averaging along an averaging distance .....	72

G.3.1	General .....	72
G.3.2	Algorithm to construct the integration path .....	73
Annex H (informative)	Code verification and model validations .....	74
H.1	Code verification .....	74
H.1.1	Introduction .....	74
H.1.2	Quasi-static codes .....	74
H.1.3	Quasi-static codes for the calculation of the incident magnetic field .....	75
H.1.4	Averaging algorithms .....	76
H.2	Model validation .....	77
H.2.1	Introduction .....	77
H.2.2	Recommendations for the development of the numerical model .....	78
H.2.3	Determining the validity of the field source .....	78
Annex I (informative)	Use cases .....	80
I.1	EV (SWPT) .....	80
I.1.1	Determination of user position .....	80
I.1.2	Assessment procedures considering direct effects for WPT system for EV .....	81
I.1.3	Assessment procedures considering indirect effects for WPT system for EV .....	86
I.2	Heavy duty vehicle EMF measurement procedure .....	91
I.2.1	General .....	91
I.2.2	Step 1 .....	91
I.2.3	Step 2 .....	93
I.2.4	Step 3 .....	93
I.3	Drone .....	94
I.3.1	Introduction .....	94
I.3.2	Assessment procedures of WPT system for drone .....	94
Annex J (informative)	Examples of assessment results .....	98
J.1	General .....	98
J.2	Assessment procedure of heavy-duty WPT EV system .....	98
J.2.1	Outline of assessment procedure .....	98
J.2.2	Test condition .....	98
J.2.3	Test result 1 .....	99
J.2.4	Test result 2 .....	99
J.3	Drone .....	100
J.3.1	Introduction .....	100
J.3.2	Description of WPT system for drone .....	100
J.3.3	Measurement of magnetic field around the WPT system for drone .....	100
J.3.4	Modelling for the WPT system for drone .....	101
J.3.5	Evaluation of incident field against basic restrictions .....	102
J.3.6	Evaluation of current density, internal electric field, and SAR against basic restrictions .....	104
J.4	Combined method of experimental and numerical analysis .....	105
J.4.1	General .....	105
J.4.2	Measurement of magnetic field .....	105
J.4.3	Numerical analyses of induced quantities .....	106
J.4.4	Example of exposure assessment for WPT systems using combined method .....	106
J.5	SAR measurement for WPT system .....	110

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Annex K (informative) Proximity detection sensor considerations for compliance assessment .....	112
K.1 Proximity detection sensor considerations .....	112
K.1.1 General .....	112
K.1.2 Phantom definition .....	112
K.1.3 Test preparation .....	112
K.1.4 Procedures for determining stationary living objects .....	113
K.1.5 Procedures for determining proximity detection sensor triggering distance .....	114
Bibliography .....	115
Figure 1 – Flowchart for the assessment procedure .....	16
Figure 2 – Flowchart for the assessment procedure considering the direct effect .....	17
Figure 3 – Trend of the approximation formulas as a function of the gradient [10] .....	22
Figure 4 – Two exposure situations for ungrounded and grounded metal objects .....	23
Figure 5 – Flowchart for assessment procedures for indirect effects .....	23
Figure 6 – Human body equivalent circuit proposed in IEC 60990 [23] .....	28
Figure 7 – Impedance frequency characteristics of adult male and equivalent circuits proposed in IEC 60990 [23] and evaluated values [24], [25], [26], [27] .....	28
Figure 8 – Example of contact current measurement equipment .....	29
Figure B.1 – H-field and E-field generation setup for probe calibration .....	41
Figure B.2 – H-field generation setup for dynamic range calibration .....	42
Figure B.3 – E-field generation setup for frequency response calibration .....	44
Figure B.4 – E-field generation setup for dynamic range calibration .....	45
Figure B.5 – Illustration of the transmit antenna factor evaluation setup [38] .....	51
Figure B.6 – Illustration of the sensitivity coefficients evaluation setup [38] .....	52
Figure C.1 – A recommended magnetic and electric field setup for measurement system verification and validation .....	54
Figure D.1 – Simulation model of large WPT system operating close to a) elliptical phantom and b) human body model .....	56
Figure D.2 – Different exposure conditions for human body model .....	56
Figure D.3 – Calculated SAR for circular coils with a 50 cm diameter operating at 6 cm from the elliptical phantom and heterogeneous human model .....	57
Figure D.4 – Simulation model of small WPT system operating close to a) elliptical phantom and b) human body model .....	57
Figure D.5 – Calculated SAR for the small squared coils with dimensions 10 cm × 10 cm operating at 2 cm from the elliptical phantom and heterogeneous human model .....	58
Figure D.6 – Layout of large WPT system for exposure condition of a) case A and b) case C with respect to the elliptical phantom surface .....	59
Figure D.7 – Calculated 10 g-averaged SAR versus the smaller axis of elliptical phantom $v$ normalized by coil outer diameter $D$ for a) case A ( $f_{\text{high}} = 7,54$ MHz) and b) case C ( $f_{\text{low}} = 6,14$ MHz, $f_{\text{high}} = 7,18$ MHz) .....	59
Figure D.8 – Layout of small WPT system for exposure conditions of case C with respect to a) elliptical phantom and b) rectangular phantom .....	60
Figure D.9 – Calculated 10 g-averaged SAR versus the smaller axis $v$ or width $W$ normalized by square coil diagonal $K$ for a) elliptical phantom ( $f_{\text{low}} = 6,6$ MHz, $f_{\text{high}} = 7,64$ MHz) and b) rectangular phantom ( $f_{\text{low}} = 6,59$ MHz) .....	60

Figure E.1 – Schematic diagram of measurement system .....	63
Figure E.2 – Measurement system .....	63
Figure E.3 – Measured and simulated electric field distributions in the measurement plane 2,5 cm away from the phantom boundary in the case of the solenoid-type WPT system .....	63
Figure E.4 – Measured and simulated electric field distributions in the measurement plane 2,5 cm away from the phantom boundary in the case of the flat-spiral-type WPT system .....	64
Figure E.5 – 10 g averaged SAR obtained by measurement with extrapolation and MoM-derived 10 g averaged SAR .....	64
Figure G.1 – Field components on voxel edges .....	71
Figure I.1 – Example for areas of protection, for ground mounted systems (vehicle) [61] .....	80
Figure I.2 – Example for areas of protection, for ground mounted systems (using vehicle mimic plate) .....	81
Figure I.3 – Flowchart for EV and vehicle mimic plate assessment (direct effect) .....	82
Figure I.4 – Area 2 measurement position (SWPT) .....	83
Figure I.5 – Area 3 measurement position .....	84
Figure I.6 – Area 2 measurement position of vehicle mimic plate (SWPT) .....	85
Figure I.7 – Area 2 measurement position of vehicle mimic plate (SWPT) .....	85
Figure I.8 – Flowchart for EV use and vehicle mimic plate assessment (indirect effect) .....	87
Figure I.9 – Configuration example of contact current with grounded condition: (1) with vehicle .....	88
Figure I.10 – Configuration example of contact current with grounded condition: (2) with vehicle mimic plate .....	89
Figure I.11 – Configuration example of contact current with ungrounded condition: (1) with vehicle .....	90
Figure I.12 – Configuration example of contact current with ungrounded condition: (2) with vehicle mimic plate .....	91
Figure I.13 – EMF measurement for heavy duty vehicle: top view .....	92
Figure I.14 – EMF measurement for heavy duty vehicle: side view .....	92
Figure I.15 – Measurement points on the inside floor of WPT bus .....	94
Figure I.16 – Measurement position .....	95
Figure J.1 – EMF test of an electrical bus (August 7, 2015, Sejong City) .....	98
Figure J.2 – Test result 1 from side-view .....	99
Figure J.3 – Test result 2 on separation distance from bus surface .....	99
Figure J.4 – Geometry and measurement position of WPT system for drone .....	101
Figure J.5 – Measured magnetic field strength .....	101
Figure J.6 – Measured and computed magnetic field strength .....	102
Figure J.7 – Measurement system for the magnetic near-field of WPT systems [33] .....	106
Figure J.8 – Schematic view and picture of the fabricated magnetic-field probes [33] .....	106
Figure J.9 – Schematic view (left) and picture (right) of WPT systems [33] .....	107
Figure J.10 – Exposure conditions for WPT coils [33] .....	108
Figure J.11 – Amplitude and phase distributions of magnetic fields measured near WPT systems without and with ferrite tiles [33] .....	109
Figure J.12 – Distribution of the internal electric field strength with adult male model for an input power of 7,7 kW [33] .....	109
Figure J.13 – WPT system operating at 6,78 MHz .....	110



Figure J.14 – SAR distribution on a plane at 25 mm from the bottom of the phantom .....	111
Figure K.1 – Test side consideration drawing.....	113
Figure K.2 – Positioning of the phantom and the DUT WPT for determining the detection sensor triggering distance, an example of charging an electric vehicle with a WPT system .....	113
Table 1 – Dielectric properties of the tissue equivalent liquid as specified in IEC/IEEE 62209-1528 .....	27
Table 2 – Dielectric properties of the tissue equivalent NaCl solution of 0,074 mol/L .....	27
Table 3 – Computational methods.....	30
Table 4 – Example of uncertainty evaluation of the exposure assessment using measurement methods.....	33
Table 5 – Example of uncertainty evaluation of numerical methods.....	34
Table 6 – Example of uncertainty evaluation of the exposure assessment combining measurements and numerical methods .....	35
Table B.1 – EM field generation setups for probe and sensor calibrations.....	39
Table B.2 – Main components of H-field and E-field generation setup for frequency response calibration.....	41
Table B.3 – Template for uncertainty in frequency response calibration .....	42
Table B.4 – Main components of H-field generation setup for dynamic range calibration.....	43
Table B.5 – Template for uncertainty in H-field dynamic range calibration.....	43
Table B.6 – Main components of E-field generation setup for frequency response calibration.....	44
Table B.7 – Template for uncertainty in E-field frequency response calibration .....	45
Table B.8 – Main components of E-field generation setup for dynamic range calibration .....	46
Table B.9 – Template for uncertainty in E-field frequency response calibration .....	47
Table B.10 – Template for uncertainty in H-field dynamic range calibration.....	49
Table B.11 – Uncertainty template for evaluation of average electric field produced by short dipole antenna via transmit antenna factor .....	52
Table E.1 – Measurement uncertainty of 10 g averaged SAR.....	65
Table H.1 – Interpolation and superposition of vector field components; maximum permissible deviation from the reference results is $\pm 1,0$ % .....	76
Table J.1 – Computed coupling factor $k_L$ .....	103
Table J.2 – Evaluation results using coupling factor $k_L$ .....	103
Table J.3 – Evaluation results using coupling factor $k_G$ .....	104
Table J.4 – Numerical computation results of current density ( $J$ ), internal electric field ( $E$ ), and spatial peak 10 g average SAR ( $SAR_{10\text{ g}}$ ).....	105

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# ASSESSMENT METHODS OF THE HUMAN EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS FROM WIRELESS POWER TRANSFER SYSTEMS – MODELS, INSTRUMENTATION, MEASUREMENT AND NUMERICAL METHODS AND PROCEDURES (FREQUENCY RANGE OF 1 kHz TO 30 MHz)

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## INTRODUCTION

The scope of this document falls under the IEC work item "development of standard for measurement and calculation methods used to assess human exposure to electric, magnetic and electromagnetic fields." Wireless power transfer (WPT) is the transmission of electrical power from a transmitter to a receiver without current-carrying wires. This technology is increasingly being implemented in a wide range of applications at different frequency ranges from consumer electronics (e.g. mobile phones, tablet PCs) to automotive (electric vehicles (EVs)). The human exposure is limited to avoid hazardous nerve effects (< 10 MHz) and thermal effects (> 100 kHz). An ITU-R published report (ITU-R SM. 2303-1) from June 2015 on WPT systems describes RF exposure assessment methodologies, yet no definitive assessment method was introduced. An exposure assessment method of WPT for EV was described in IEC 61980-3:2019, however, there is currently no other product standard related to WPT. As WPT systems will become ubiquitous in a multitude of applications in the near future, IEC and IEEE established a joint working group to address WPT assessment methods related to human exposures to electric, magnetic and electromagnetic fields.

In this document, IEC TC 106 describes the basic methods to assess the direct and indirect effects of exposure to WPT systems, case studies, and relevant research. These methods mainly focus on frequency up to 30 MHz to consider both stimulation and thermal effects. The document specifies:

- assessment procedures (Clause 5);
- measurement methods (Clause 6);
- numerical assessment methods (Clause 7);
- assessment combining measurement and numerical methods (Clause 8).

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## 1 Scope

The objective of this document is to specify the assessment methods to evaluate compliance of stationary and dynamic wireless power transfer (WPT) systems with electromagnetic human exposure guidelines (external electric and magnetic fields, specific absorption rate (SAR), internal electric fields or current density including contact currents). The frequency range of this document is from 1 kHz to 30 MHz.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

ISO/IEC Guide 98-1:2009, *Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement* (GUM:1995)

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61786-1:2013, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring instruments*

IEC 61786-2:2014, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 2: Basic standard for measurements*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
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### 3.1 basic restriction BR

restriction on exposure to time-varying electric, magnetic and electromagnetic fields that is based directly on established health effects.

Note 1 to entry: Examples of basic restrictions can be found in Annex II of the Council Recommendation 1999/519/EC [1], ICNIRP Guidelines [2], [3], [4], IEEE Std C95.6 [5] and IEEE Std C95.1 [6], [7], [8].

[SOURCE: IEC 62311:2019 [12], 3.1.2]

### 3.2 complex relative permittivity

under sinusoidal conditions in a medium where the phasors  $\underline{D}$  and  $\underline{E}$  representing respectively the electric flux density and the electric field strength are linearly related, complex quantity  $\underline{\varepsilon}_r$  defined by the relation

$$\underline{D} = \varepsilon_0 \underline{\varepsilon}_r \underline{E}$$

where  $\varepsilon_0$  is the electric constant

Note 1 to entry: The complex relative permittivity is generally frequency dependent. For an isotropic medium the complex relative permittivity is a scalar; for an anisotropic medium it is a tensor.

Note 2 to entry: Generally  $\underline{\varepsilon}_r$  is expressed as  $\underline{\varepsilon}_r = \varepsilon'_r - j\varepsilon''_r$  where  $\varepsilon'_r$  is the real relative permittivity and  $\varepsilon''_r$  is the dielectric loss index which represents dielectric losses.

[SOURCE: IEC 60050-121:2019, 121-12-14]

### 3.3 contact current

<for human body> current flowing into the body resulting from contact with a conductive object in an electromagnetic field.

Note 1 to entry: This is the localized current flow into the body (usually the hand, for a light brushing contact).

### 3.4 coupling factor

factor which correlates the measured incident field to the induced field in the human body

### 3.5 current density

<in a body> current density induced inside the body as a result of exposure to electromagnetic fields.

### 3.6 device under test DUT

device that is tested according to the procedures specified in this document.

### 3.7 direct effect

biological effect resulting from direct interaction of electromagnetic field with biological structures.

[SOURCE: ICNIRP Guidelines:2010 [3]]

**3.8****dynamic wireless power transfer****DWPT**

transmission of electrical energy by electromagnetic fields, in which the secondary device (connected to the electrical load) is intentionally moving with respect to the primary device (connected to the power source) or along a track of multiple power sources acting as the primary device.

**3.9****electric field strength**

vector field quantity  $E$  which exerts on any charged particle at rest a force  $F$  equal to the product of  $E$  and the electric charge  $Q$  of the particle:

$$F = QE$$

[SOURCE: IEC 60050-121:1998, 121-11-18]

**3.10****exposure**

<of a body> situation that occurs wherever a person is subjected to electric, magnetic or electromagnetic fields

**3.11****incident field**

field that would exist in the absence of a person at a point where a person could be located

Note 1 to entry: In some documents, the incident field is called an unperturbed field or environmental field.

**3.12****indirect effect**

biological effect resulting from indirect interactions of electromagnetic fields with biological structures such as contact currents

**3.13****internal electric field**

<in a body> electric field induced inside the body as a result of exposure to electromagnetic fields

**3.14****magnetic field gradient**

variation of the magnetic field with respect to the position

**3.15****magnetic field strength**

magnitude of the vector quantity obtained at a given point by subtracting the magnetization  $M$  from the magnetic flux density  $B$  divided by the magnetic constant  $\mu_0$

[SOURCE: IEC 60050-121:1998, 121-11-56, modified – "magnitude of the" has been added at the start of the definition.]

**3.16****peak spatial-average SAR****psSAR**

maximum average SAR within a local region based on a specific averaging volume or mass, e.g. any 1 g or 10 g of tissue in the shape of a cube